THE STRONG JET OVER THE SOUTHWESTERN PLAINS STATES, NOVEMBER 24–25, 1953

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INTRODUCTION

During the period November 22–27, 1953 the 300-mb. jet entering the west coast of North America strengthened and moved east-southeastward to the Gulf of Mexico, then northeastward up the east coast. From 0300 GMT November 24 to 1500 GMT November 25 inclusive some high speed, upper level winds were reported including the following:

Between 150 and 200 knots	*Over 200 knots*
Denver, Colo.	Lander, Wyo.
Amarillo, Tex.	Oklahoma City, Okla.
St. Cloud, Minn.	
Oklahoma City, Okla.	

As such wind speeds are not often observed it was felt that an investigation of the flow in the region surrounding this strong jet stream might throw some light on the processes occurring during times of maximum winds.

This present paper deals with the methods used in constructing various charts from which a study was made of the relationship of the position of the jet to special features at other levels, the movement of areas of wind speed maxima, and the calculated maximum speeds.

As the time allotted for this study was limited, a small area, covering only the southwestern Plains States, was chosen in order to assure an accurate analysis on all charts. The charts discussed are for 1500 and 2100 GMT on the 24th and 0300 and 1500 GMT on the 25th.

CONSTRUCTION OF CHARTS

The first step in this study was the precise analysis of the 300-mb. charts to be used. The 300-mb. level was chosen because it is high enough to be near the level of maximum winds and low enough to supply an appreciable number of reports. As an aid in obtaining an accurate 300-mb. analysis, one that would be consistent with lower level analysis, the 700-mb. chart, on which the data coverage is usually adequate, was chosen as a base for a thickness buildup to 300-mb.

After the 700-mb. charts were analyzed, the 700 to 300-mb. thermal winds were computed and plotted along with the 700 to 300-mb. height difference values. In analyzing the 700 to 300-mb. height difference charts, it was noted that in some cases the thermal winds were inconsistent with the gradient of height differences. In such cases, the height differences were assumed to be more nearly correct. The 300-mb. charts were then constructed by graphical addition of the 700-mb. charts and 700 to 300-mb. height difference charts. The intermediate 300-mb. chart for 2100 GMT, because of the sparsity of data, was constructed in the following manner. Mean charts were analyzed for the 700-mb. level and 700 to 300-mb. height difference from the data for 1500 GMT on the 24th and 0300 GMT on the 25th. From these mean charts a 300-mb. chart was constructed and then adjusted to fit available 2100 GMT data.

The 300-mb. contours were given a minimum of smoothing since smoothing of the analysis eradicates the very features that one desires to find, i. e., variations in the strength of the winds [1].

The next task was to locate the jet axes on the 300-mb. charts. In locating these jet axes, the following empirical rules were used: (1) The 300-mb. jet axis in nearly all cases is located above or slightly to the left of the 500-mb. jet axis when the jet extends down to the 500-mb. level [1]. (2) A jet axis with strong winds below the 200-mb. level is usually situated parallel to the 200-mb. isotherms and below the zone of isotherm concentration, with cold air to the right and warm air to the left of the axis looking downstream [1]. (3) The axis of the jet is usually coincident with the zone of maximum packing of contours located by use of geostrophic wind measurements. (4) The maximum isotach gradient is usually to the left of the jet axis looking downstream.

FEATURES OF THE JET

The position of the jet axis on the 1500 GMT chart of the 24th (fig. 1) was over central Wyoming and Colorado, southern Oklahoma and Arkansas. A velocity maximum extended into Wyoming, while another was centered near the Texas Panhandle. An irregularity in the isotach pattern can be noticed over central Texas where a jet finger had already appeared. If we look at the correspondence between the concentration of the 200-mb. isotherms and the position of the 300-mb. jet (fig. 2), we

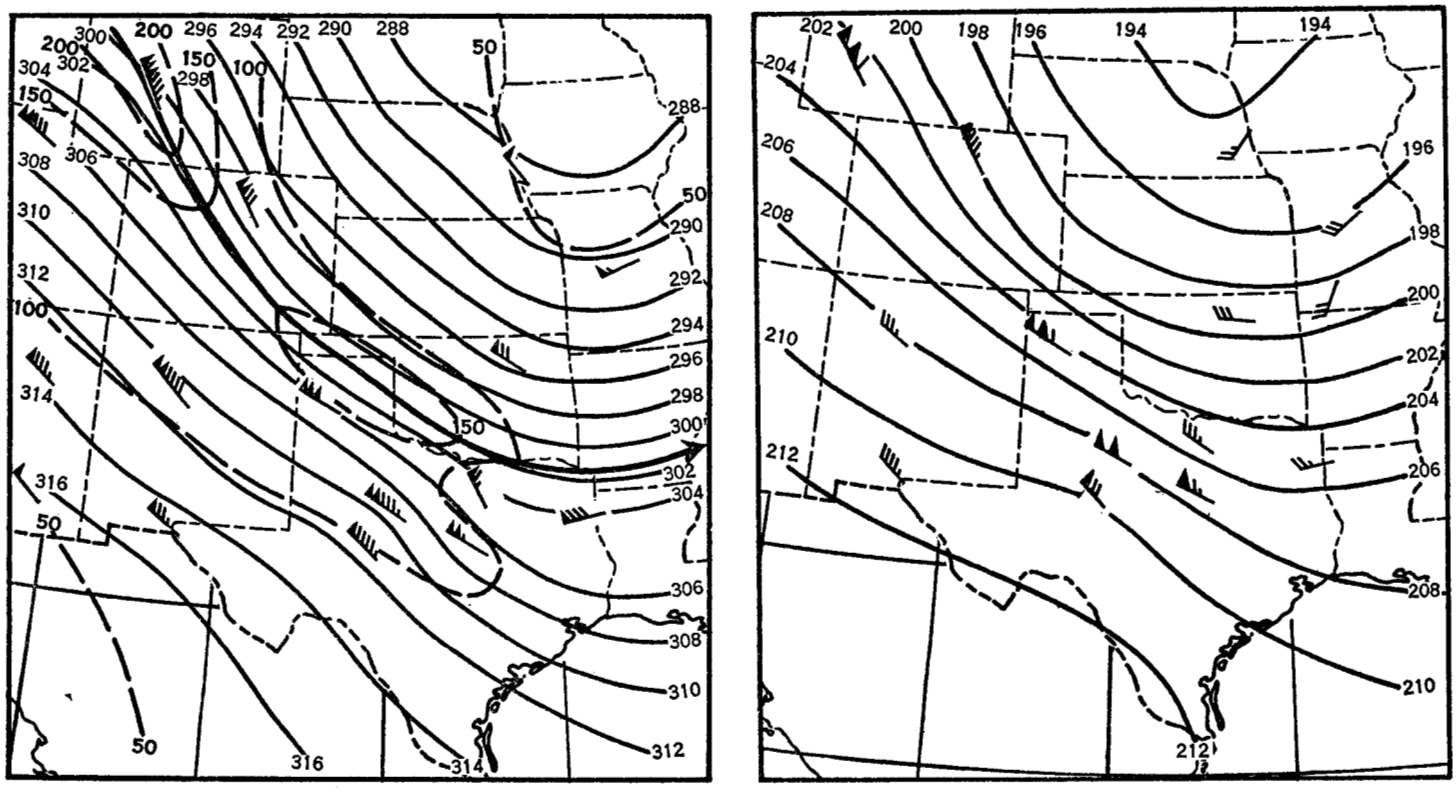

FIGURE 1.—Left: 300-mb. chart for 1500 GMT, November 24, 1953 showing contours (solid lines) and isotachs labeled in knots (dashed lines). Jet is heavy arrowed line. Right: 700-300-mb. height difference chart for 1500 GMT, November 24, 1953.

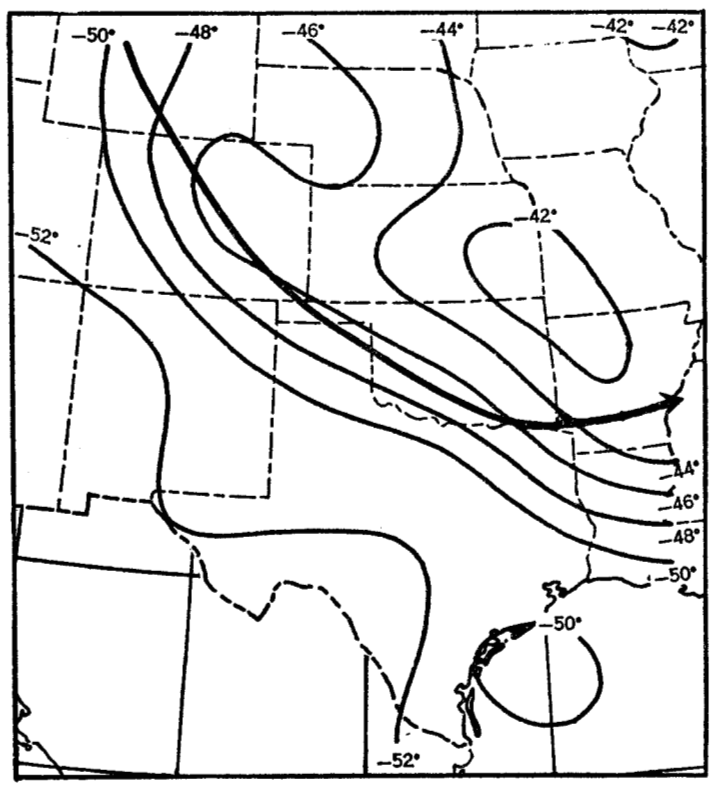

FIGURE 2.—200-mb. isotherms analyzed for 2° C. intervals superimposed on 300-mb. jet for 1500 GMT, November 24, 1953.

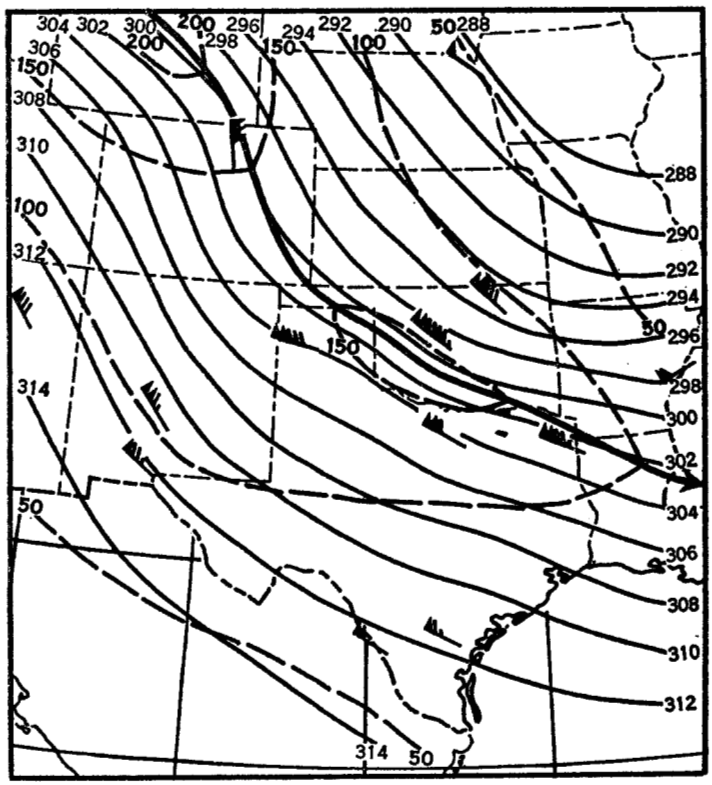

FIGURE 3.—300-mb. chart for 2100 GMT, November 24, 1953 showing contours and isotachs labeled in knots. Jet is heavy arrowed line.

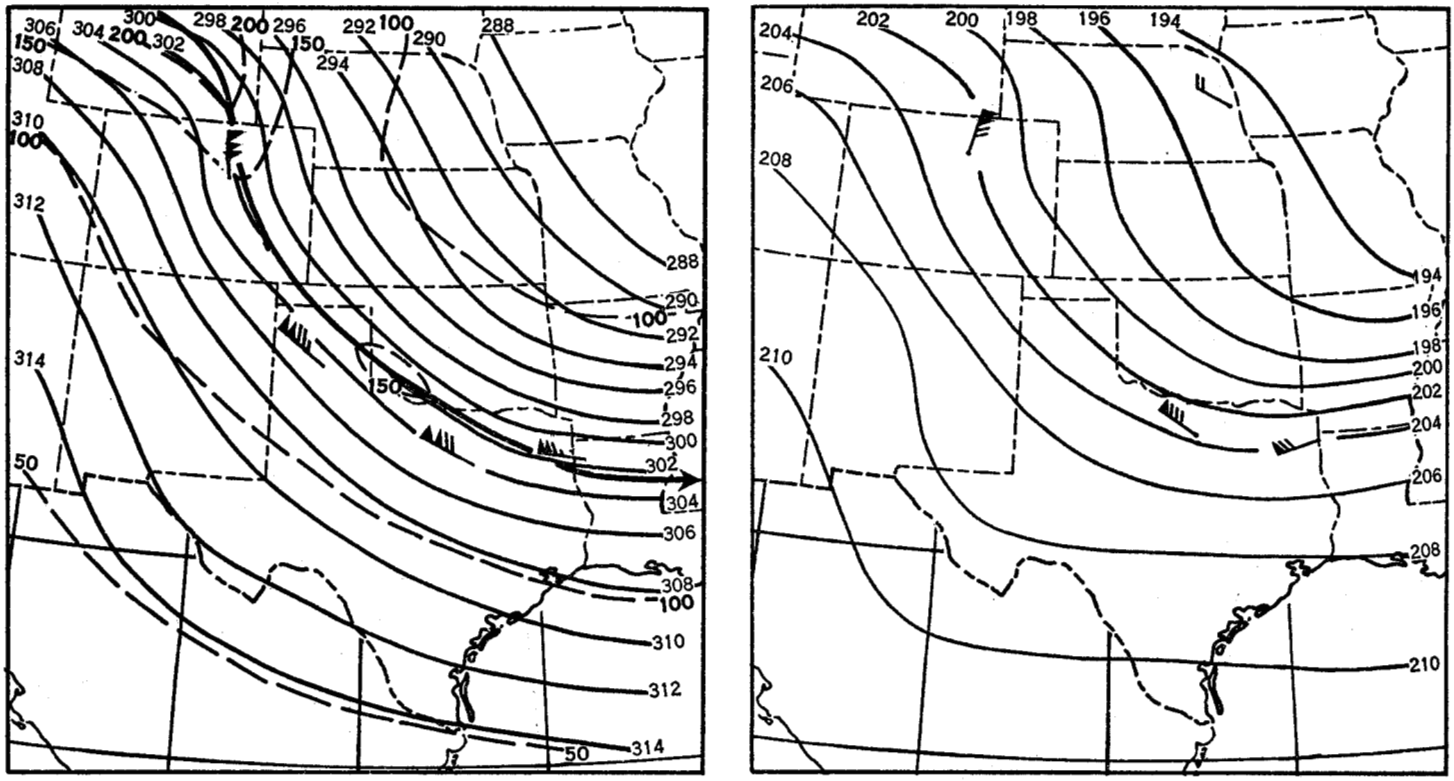

FIGURE 4.—Left: 300-mb. chart for 0300 GMT, November 25, 1953 showing contours (solid lines) and isotachs labeled in knots (dashed lines). Jet is heavy arrowed line. Right: 700-300-mb. height difference chart for 0300 GMT, November 25, 1953.

find an inconsistency in the Arkansas-Louisiana area where the 300-mb. jet did not coincide with the packing of the 200-mb. isotherms. However, it may be seen from the isotachs (fig. 1) that the jet finger, already started in central Texas, did coincide with the area of concentration of 200-mb. isotherms, and by 2100 GMT (fig. 3) this jet finger had become the main axis of the jet. During other periods the relation over the entire area was not as good as during the period just mentioned, although there were areas along the 300-mb. jet axes where the 200-mb. isotherms did show a marked packing.

A very good relation was also found between the jet stream and the polar front at the 500-mb. level. The jet axis at the 500-mb. level was found along the southern edge of the polar front isothermal ribbon between −17° and −.23° C. [2].

Marked packing of the 700 to 300-mb. thickness lines can be noticed in the Texas and Oklahoma Panhandles at 1500 GMT on the 24th (fig. 1). This packing had moved into southeastern Oklahoma by 2100 GMT and eastward over Arkansas and Mississippi by 0300 GMT on the 25th (fig. 4).

Figure 5 shows a relation between the tropopause break lines and the 300-mb. jet at 1500 GMT on the 24th. The jet paralleled the main break line throughout the area except over Arkansas and Louisiana. However, as mentioned earlier, the jet was weakening over Arkansas and re-forming over Louisiana at this time.

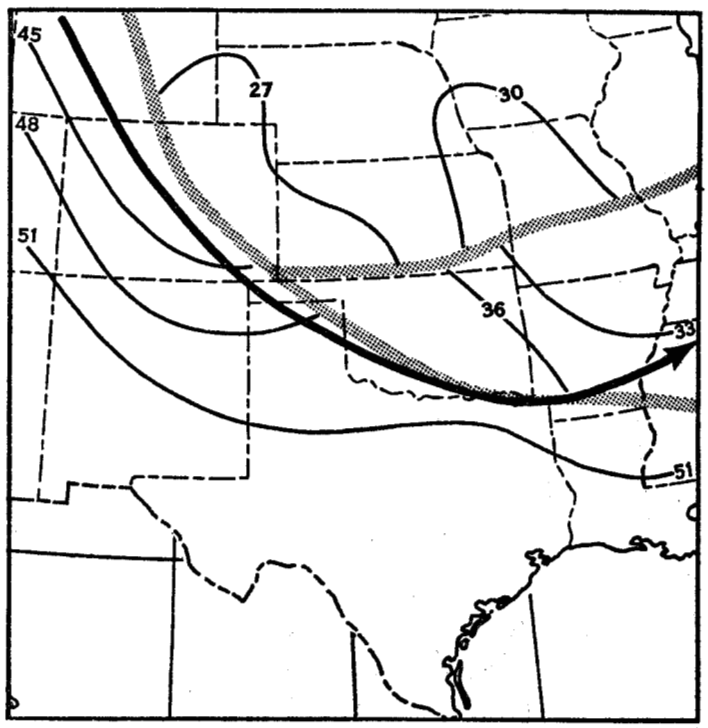

FIGURE 5.—Tropopause breaks (stippled line) superimposed on 300-mb. jet (solid arrow) for 1500 GMT, November 24, 1953. Tropopause height lines are labeled in thousands of feet.

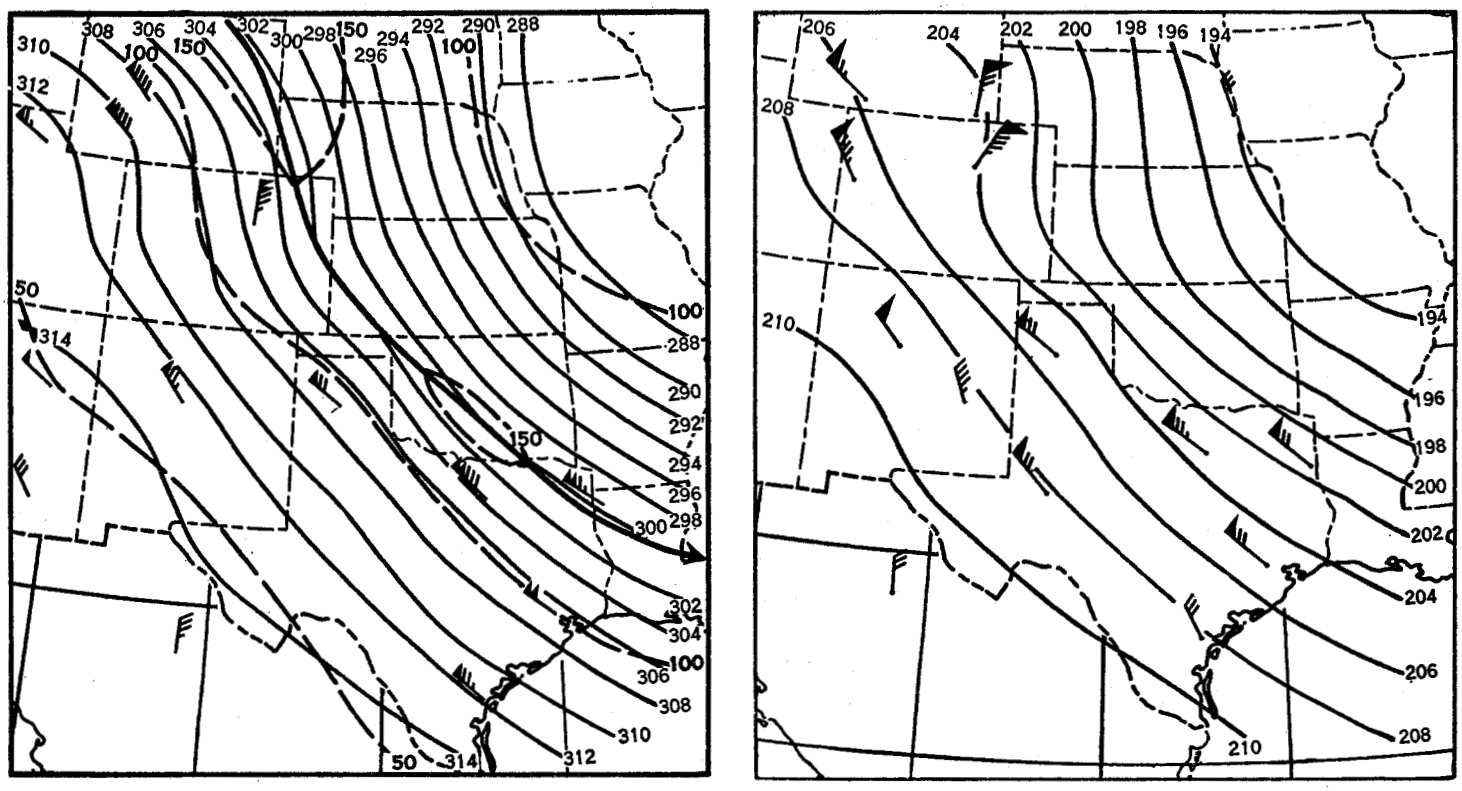

FIGURE 6.—Left: 300-mb. chart for 1500 GMT, November 25, 1953, showing contours (solid lines) and isotachs labeled in knots (dashed lines). Jet is heavy arrowed line. Right: 700-300-mb. height difference chart for 1500 GMT, November 25, 1953.

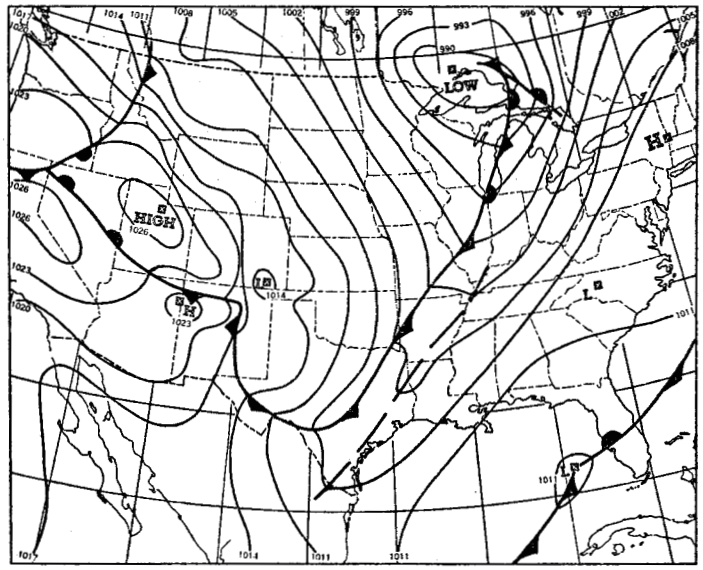

FIGURE 7.—Surface chart for 1230 GMT, November 24, 1953.

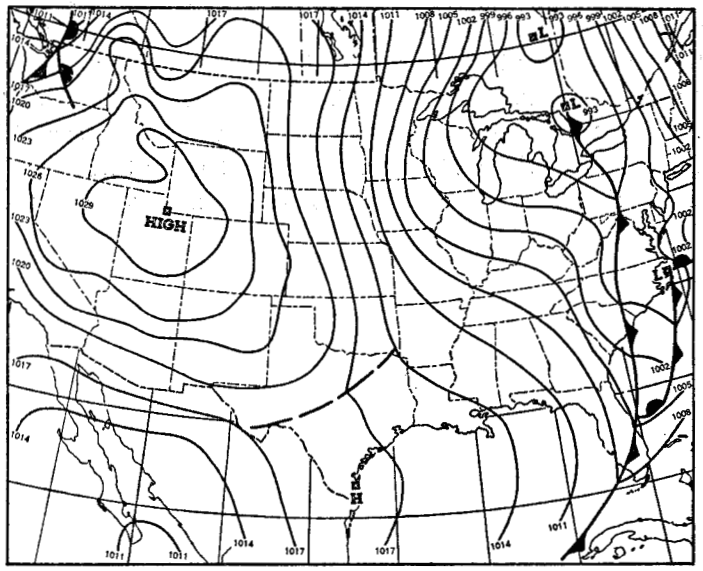

FIGURE 8.—Surface chart for 1230 GMT, November 25, 1953. Note rapid movement of front in 24 hours from time of figure 7.

The changes in the position of the jet axis at 300 mb. over the period of time under study were only slight (figs. 1, 3, 4, and 6). The least change occurred over southeastern Oklahoma where the jet axis remained nearly stationary and pivoted to acquire a more north-south tilt.

The two jet maxima at 1500 GMT on the 24th (fig. 1), one in Wyoming and the other over the Texas Panhandle, moved very little during the period. The maximum over Wyoming, which occurred within anticyclonic flow, appeared to stay at approximately the same latitude and to move eastward with the ridge rather than downstream. The maximum over the Texas Panhandle moved southeastward. An interesting feature in connection with this maximum was the anticyclonic curvature at 300 mb. between Amarillo and Fort Worth (fig. 1). This anticylonic curvature was evident at all levels, 700 to 150 mb.,

at 1500 GMT on the 24th. It was still evident on the intermediate 300-mb. chart for 2100 GMT (fig. 3) but had disappeared by 0300 GMT on the 25th (fig. 4).

Although it is believed that winds in excess of 200 knots did exist within the Texas Panhandle maximum area (fig. 1) (measurements using the geostrophic wind scale showed winds in the neighborhood of 250 knots), isotachs for values of more than 150 knots were not drawn as it was felt that stronger winds were local and did not cover a well defined area. As the observation at Tinker Field, Oklahoma City, of a maximum wind in the neighborhood of 250 knots at about 40,000 feet was made only 5 hours after the time of figure 1, it is feasible that with a moderate rate of movement this maximum area could move downstream to the vicinity of Oklahoma City. The 2100 GMT chart (fig. 3) reveals that this maximum area did move downstream to just south of Oklahoma City with a contour spacing (using 100-ft. contour intervals as originally analyzed) which indicates geostrophic winds in excess of 250 knots.

The main surface indication of this strong jet stream was the rapid movement of the polar front (figs. 7 and 8) in the 24 hours ending at 1230 GMT, November 25. The Great Plains area was dominated during this period by strong northwesterly to northerly flow and the front was pushed rapidly southward and eastward at an average rate of 36 knots for the 24-hour period.

The 500-mb. pattern showed a quasi-stationary trough off the west coast, a ridge over the west coast, a trough through the central United States, and a ridge over the Atlantic Ocean at about the 45th meridian. About 1500 GMT on the 24th, a closed Low formed east of International Falls, Minn., deepening steadily throughout the period as cold air was advected into it from the northwest. This marked cold advection lowered 500-mb. temperatures as much as 11° C. in 12 hours at some stations. At the same time, the ridge over the west coast moved slowly eastward. These processes were accompanied by a packing of the contours in the area under study.

CONCLUSION

It was realized before this study was undertaken that there is question as to the absolute accuracy of wind measurements in the vicinity of a jet axis. It was felt, however, that by careful analysis of the previously mentioned charts the jet maxima could be found and a probable maximum wind determined. It should also be understood that for anticyclonic circulation a positive correction may be required. With any additional speed due to anticyclonic circulation added to the speed already calculated, a probable maximum for the Oklahoma area (fig. 3) might approach 300 knots.

ACKNOWLEDGMENTS

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